PATENT ABSTRACTS OF JAPAN

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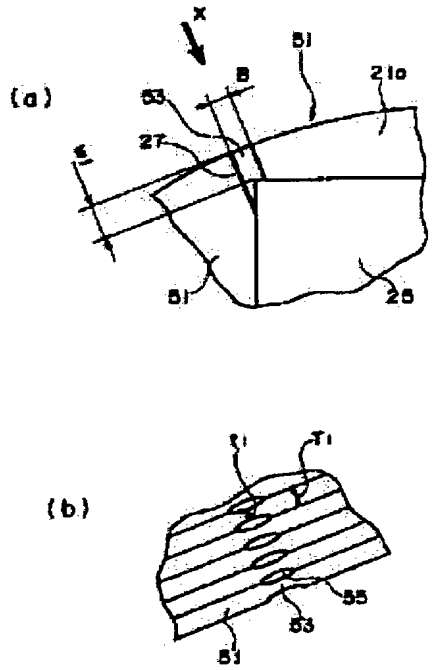
(54) MAGNETIC POLE LAMINATE OF ROTATING MACHINE

(57)Abstract:
PROBLEM TO BE SOLVED: To ensure the strength of transition sections, and to prevent deformation and breaking while reducing leakage flux, by installing work hardening sections by compressive deformation among magnetic poles in each laminated plate consisting of disks or ring-shapes having a fixed number of the magnetic poles on circumferences or the narrow-width transition sections tying the magnetic poles and other laminated plate sections.
SOLUTION: Work hardening sections 53, to which compressive deformation treatment is executed, are mounted on parts of the transition sections 27 of each laminated plate 51 constituting the pole laminate of a rotor interposed in a stator for a rotating machine. Since the work hardening sections 53 are kept within a range in the circumferential direction B centering around the shoulder section corner of an opening section 25 for a magnet, the wall thickness t1 is made thinner than those T1 of other sections of the laminated plates 51, and air gaps 55 are generated among each laminated plate 51. Accordingly, strength against external force in the work hardening sections 53 is increased while reluctance is elevated, the strength of the transition sections 27 is ensured and deformation and breaking are prevented, and leakage flux is redeuced and the performance of the rotating machine can be improved. The same treatment can also be conducted in the stator for the rotating machine.



CLAIMS

[Claim(s)]
[Claim 1]In a magnetic pole layered product of a rotating machine formed by laminating, a laminate sheet each laminate sheet, A magnetic pole layered product of a rotating machine, wherein it consists of a disk or ring form which forms a magnetic pole of a predetermined number on a circumference, and is connected with a passage part with a narrow laminate sheet portion to a magnetic pole in addition to this between magnetic poles and a work-hardening part by a compression set is provided in this passage part.
[Claim 2]In a magnetic pole layered product of the rotating machine according to claim 1, this magnetic pole layered product, It is used for a rotor interpolated in a stator of a rotating machine, and to said laminate sheet. A magnetic pole layered product of a rotating machine which an opening for magnets for inserting a rotor magnet is provided near a rotor periphery, forms said magnetic pole in the outside of this opening for magnets, and is characterized by said passage part being a narrow portion between a shoulder of said opening for magnets, and a rotor periphery.
[Claim 3]In a magnetic pole layered product of the rotating machine according to claim 1, said magnetic pole layered product, A magnetic pole layered product of a rotating machine which it is used for a stator of a rotating machine, and said laminate sheet arranges annularly two or more convex poles for winding stator winding, is formed in ring form, and is characterized by said passage part being a narrow connecting part which connects between said convex poles by the inner circumference side.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the magnetic pole layered product of a rotating machine, and the magnetic pole layered product of the rotating machine especially formed by being used for a rotor or a stator and laminating a laminate sheet.
[0002]
[Description of the Prior Art]Conventionally, the magnetic pole layered product formed in the stator and rotor of a rotating machine (a motor or a dynamo) by laminating a laminate sheet is used. As a laminate sheet, the steel plate which consists of a charge of high magnetic permeability deadwood, for example is used. By this laminated structure, eddy current loss is stopped few. Hereafter, the motor provided with the stator and rotor of such a laminated structure is explained as conventional technology.
[0003]"Conventional technology 1" drawing 4 is a sectional view showing the composition of the motor used conventionally. This motor is provided with the rotor 3 interpolated in the stator 1 and the stator 1.
It is the inner magnet type permanent magnet motor which provided the permanent magnet in the rotor 3.

[0004]The stator body 5 of the stator 1 laminates the stator laminate sheet 7 of the ring form of about 0.5 mm of board thickness, and is formed in the shape of a cartridge. As it projects to the inner circumference side, the six convex poles 9 are formed in the stator body 5. The six convex poles 9 are formed at equal intervals, and are respectively formed in the stator body 5 at one. The inner skin of each convex pole 9 is a cylinder side, and is set up separate a fixed crevice from the peripheral face of the rotor 3, and counter. The stator coil is formed by winding the stator winding 11 around each convex pole 9 like a graphic display.
[0005]The rotor body 13 of the rotor 3 laminates the rotor laminate sheet 15 of the ring form of about 0.5 mm of board thickness, and is formed in cylindrical shape. The axis of rotation 17 is fixed in the center of the rotor body 13, and this axis of rotation 17 is supported pivotally by the motor case which is not illustrated. The rotor magnet 19 is being fixed to two places (position which shifted the phase about 180 degrees) which face near the peripheral face of the rotor body 13 each other on both sides of a center. And the portion by the side of the periphery of the rotor magnet 19 in the rotor body 13 serves as the magnetic pole 21. That is, the magnetic flux produced in the rotor magnet 19 goes in and out from the rotor 3 through the magnetic pole 21.
[0006]Drawing 5 is a top view of the rotor laminate sheet 15. The axial circular attaching hole 23 for inserting the axis of rotation 17 is formed in the center of the rotor laminate sheet 15. The opening 25 for magnets of the rectangle for inserting the rotor magnet 19 is formed near the peripheral face of the rotor laminate sheet 15. The periphery side of the opening 25 for magnets is the magnetic pole 21a. This magnetic pole 21a is laminated and the magnetic pole 21 of the above-mentioned rotor body 13 is formed. Here, let the narrow portion between the shoulder of the opening 25 for magnets, and a rotor periphery be the passage part 27. The passage part 27 is a portion which connects the magnetic pole 21a and other rotor laminate sheet 15 portions.
[0007]The composition of the conventional motor shown in drawing 4 was explained above. A revolving magnetic field occurs by supplying alternating current to the stator winding 11 at the time of operation of a motor. On the other hand with the rotor 3, a magnetic field occurs in the magnetic pole 21 with the rotor magnet 19. By the magnetic action of the revolving magnetic field of the stator 1, and the magnetic field of the rotor 3, torque acts on the rotor 3 and the rotor 3 rotates.
[0008]"Conventional technology 2" drawing 6 is a sectional view showing the composition of the motor of the conventional technology 2. In this motor, the composition of the stator body 33 in the stator 31 differs from the conventional technology 1. The stator body 33 is block construction and consists of the stator outer case 35 and the stator container liner 37 inserted in this stator outer case 35 without the crevice.
[0009]The stator outer case 35 laminates the stator outer case laminate sheet 39 of the ring form of about 0.5 mm of board thickness, and is formed in cylindrical shape. The stator container liner 37 also laminates the stator container liner laminate sheet 41 of the ring form of about 0.5 mm of board thickness, and is formed in the shape of a cartridge. The six convex poles 43 are formed in the hoop direction at equal intervals at the stator container

liner 37. And the ****** convex pole 43 is connected by the connecting part 45 by the inner circumference side. The inner skin (namely, inner skin of the pipe formed of the convex pole 43 and the connecting part 45) of the stator container liner 37 is a cylinder side, and is set up separate a fixed crevice from the peripheral face of the rotor 3, and counter. The peripheral face (namely, field of the outside of each convex pole 43) of the stator container liner 37 is also a cylinder side. The stator container liner 37 is pressed fit in the stator outer case 35, and each convex pole 43 has stuck it without the stator outer case 35 and a crevice. By abolishing the crevice between the convex pole 43 and the stator outer case 35, it is easy to pass along magnetic flux among both.
[0010]Drawing 7 is a top view of the stator container liner laminate sheet 41. The six convex poles 43a are connected by the connecting part 45a corresponding to the sectional shape of the stator container liner 37. This convex pole 43a and connecting part 45a are laminated, and the above-mentioned convex pole 43 and the connecting part 45 of the stator container liner 37 are formed respectively. The connecting part 45a is a passage part which connects between the ****** convex poles 43a.
[0011]In the case of the motor of drawing 6, before inserting the stator container liner 37 in the stator outer case 35, the stator winding 11 can be twisted around the convex pole 43. Since the stator winding 11 is twisted from the outside, it twists from the case where it twists from the inside like the conventional technology 1, and work is easy. And the share of the stator winding 11 in the space between convex poles can be raised, and the number of turns of a stator coil can be increased.
[0012]
[Problem(s) to be Solved by the Invention]
"SUBJECT about conventional technology 1" drawing 8 shows the details of A portion shown in drawing 4 with the circle. The minimum width size of the radial direction of the passage part 27 is W1 like a graphic display.
[0013]Magnetic flux phia from the rotor magnet 19 to the convex pole 9 through the magnetic pole 21a is shown to drawing 8 by the arrow. Without reaching the convex pole 9, a part of magnetic flux phia was set to leak magnetic flux phib, and it has leaked from the passage part 27 to other portions of the rotor laminate sheet 15. In order to raise the performance of a motor through magnetic flux efficiently between the magnetic pole 21a and the convex pole 9, it is preferred to reduce leak magnetic flux phib as much as possible. Here, by arranging the opening 25 for magnets to the periphery side more, and narrowing width of the radial direction of the passage part 27, it can leak effectively and magnetic flux can be reduced. That is, since the magnetic resistance of the passage part 27 will increase by reduction of a cross-section area if width of the radial direction W1 of the passage part 27 is narrowed, leak magnetic flux phib decreases.
[0014]On the other hand, if the rotor 3 rotates, the centrifugal force F will act on the rotor magnet 19 like a graphic display. The bending moment acts on the passage part 27 according to the centrifugal force F. Therefore, it is necessary to set up the width of the radial direction of the passage part 27 so that neither a crack nor destruction may arise by the bending moment. Since the centrifugal force F increases in proportion to the square of rotor number of rotations, the bending moment which acts on the passage part 27 according to rotor number of rotations also becomes large. Therefore, the maximum engine speed of a motor is restricted by the flexural strength (namely, width dimension) of the passage part 27.
[0015]As mentioned above, although it is preferred to narrow width of the radial direction of the passage part 27, to leak in the conventional motor for the improved efficiency of a motor, and to reduce magnetic flux phib, for flexural strength reservation, it is difficult to narrow width of the passage part 27.
[0016]"SUBJECT about conventional technology 2" drawing 9 shows the details of B portion shown in drawing 6 with the circle. The minimum width size of the radial direction of the connecting part 45a is W2 like a graphic display.
[0017]Magnetic flux phic from the convex pole 43a to the magnetic pole 21a is shown to drawing 9 by the arrow. Without reaching the magnetic pole 21a, a part of magnetic flux phic was set to leak magnetic flux phid, and it has leaked to the connecting part 45a. Here, like the above-mentioned, in order to raise the performance of a motor through magnetic flux efficiently between the convex pole 43a and the magnetic pole 21a, it is effective to narrow width of the radial direction of the connecting part 45a, to leak, and to reduce magnetic flux phid as much as possible.
[0018]On the other hand, it is necessary to prevent a crack and destruction from arising during the handling of the stator container liner 37 at the connecting part 45 at the time of (1) motor manufacture. (2) Since the crevice between the stator 1 and the rotor 3 is made small and the performance of a motor is raised, the inner skin of the stator container liner 37 may be finished by machining. In this case, it is necessary to prevent modification of the connecting part 45 by the time of machining. (3 When it constitutes as mentioned above further again so that the stator container liner 37 may be pressed fit in the stator outer case 35, it is necessary to secure the annulus ring rigidity of the stator container liner 37, and to prevent modification.) Since the bending moment acts on the connecting part 45 by press fit, it is necessary to prevent a crack and destruction occurring in the connecting part 45 at the time of press fit. The width of the radial direction of the connecting part 45a of each stator laminate sheet 41 is set up somewhat widely meet the demand of (1) - (3).

[0019]As mentioned above, it is preferred to narrow width of the radial direction of the connecting part 45a for the improved efficiency of a motor, to leak in the motor of the conventional technology 2, and to reduce magnetic flux phid. However, since it is necessary to prevent the crack and destruction of the connecting part 45a, and to prevent modification of the stator container liner 37 at the time of press fit, it is difficult to narrow width of the connecting part 45a.
[0020]"Purpose of this invention" this invention relates to a magnetic pole layered product which was made in order to solve above-mentioned SUBJECT, laminates a laminate sheet, is formed, and forms a magnetic pole on the circumference of this laminate sheet. There is the purpose of this invention in providing the magnetic pole layered product which the magnetic resistance of the above-mentioned passage part is raised, and can reduce the leak of magnetic flux while raising the intensity to the external force of the passage part between the magnetic poles of each laminate sheet, or the passage part of a magnetic pole and other magnetic pole layered product portions. And it aims at reconciling securing the intensity of a passage part and preventing modification and destruction, and reducing leak magnetic flux and improving motor performance.
[0021]
[Means for Solving the Problem]In a magnetic pole layered product of a rotating machine formed by laminating, this invention a laminate sheet each laminate sheet, On a circumference, it consists of a disk or ring form which forms a magnetic pole of a predetermined number, and is connected between magnetic poles or with a magnetic pole and a passage part with a laminate sheet portion narrow in addition to this, and a work-hardening part by this passage part compression set is provided.
[0022]According to the above, between magnetic poles of each laminate sheet is connected with a passage part, or a magnetic pole of each laminate sheet and other laminate sheet portions are connected with a passage part. And a work-hardening part by a compression set is provided in this passage part. a passage part may all boil a work-hardening part, it may be provided, and may be provided in part. In this work-hardening part, intensity to external force is high by a compression set, and amplitude permeability becomes high, and magnetic resistance is increasing.
[0023]This magnetic pole layered product is used for a rotor interpolated in a stator of a rotating machine in one mode of this invention, and to said laminate sheet. An opening for magnets for inserting a rotor magnet is provided near a rotor periphery, said magnetic pole is formed in the outside of this opening for magnets, and said passage part is a narrow portion between a shoulder of said opening for magnets, and a rotor periphery.
[0024]The above is the gestalt which applied this invention to a rotor of a rotating machine. A magnetic pole is formed in the outside of an opening for magnets of a laminate sheet. And a narrow portion between a shoulder of an opening for magnets and a rotor periphery serves as a passage part which connects a magnetic pole and other laminate sheet portions. A work-hardening part is provided in this passage part.
[0025]In one mode of this invention, said magnetic pole layered product is used for a stator of a rotating machine, said laminate sheet arranges annularly two or more convex poles for winding stator winding, and is formed in ring form, and said passage part is a narrow connecting part which connects between said convex poles by the inner circumference side.
[0026]The above is the gestalt which applied this invention to a stator of a rotating machine. In each laminate sheet, a connecting part is provided so that between ****** convex poles may be connected by the inner circumference side, and this connecting part is a passage part which connects between magnetic poles. And a work-hardening part is provided in this passage part.
[0027]
[Embodiment of the Invention]Hereafter, an embodiment of the invention is described based on Drawings. Since the element which attached the numerals given to the element shown in above-mentioned drawing 4 - drawing 9 and identical codes has the same function, explanation is omitted.
[0028]Only the composition of the rotor laminate sheet with which the motor of "Embodiment 1" book embodiment constitutes the rotor 3 to the motor of the above-mentioned conventional technology 1 is different. Then, explanation is omitted about the composition which is common in the conventional technology 1, and only a point of difference is explained.
[0029]Drawing 1 shows the composition of the rotor laminate sheet 51 of Embodiment 1. The figure (a) is a top view of the rotor laminate sheet 51, and expands and shows the portion equivalent to the circle A of drawing 4. And the shape of the rotor laminate sheet 51 seen from the arrow X direction in drawing 1 (a) is shown in the figure (b). The figure (b) shows the state where the rotor laminate sheet 51 was laminated.
[0030]As shown in drawing 1 (a), in the rotor laminate sheet 51 of this embodiment, the work-hardening part 53 which performed compression-set processing is formed in a part of passage part 27, and the cross-section area of the portion is set up smaller than conventional technology. As shown in drawing 1 (a), the work-hardening part 53 is formed centering on the shoulder corner of the opening 25 for magnets, and the range of the work-hardening part 53 is B at a circumferencial direction. As shown in drawing 1 (b), the minimum thickness of the work-hardening part 53 is t1, and is thinner than the thickness T1 of the general part of the rotor laminate sheet

51. And since the thickness of the work-hardening part 53 is thinner than a general part, the opening 55 has produced between the rotor laminate sheets 51.
[0031]The characteristic change of the steel plate for rotor laminate sheet 51 by drawing 2 performing compression-set processing is shown. The figure shows the characteristic at the time of performing cold rolling working as compression-set processing. In the figure, a horizontal axis is a deformation degree (degree of modification by compression-set processing), and a vertical axis is the tensile strength and amplitude permeability of a steel plate. Tensile strength is increasing, so that a deformation degree increases, as shown in the figure. The increase in tensile strength is based on work hardening at the time of a compression set. Amplitude permeability is falling, so that a deformation degree increases. Thus, the two characteristics of tensile strength and amplitude permeability can be simultaneously changed by performing compression-set processing.
[0032]In the work-hardening part 53, tensile strength is increasing from the general part of the rotor laminate sheet 51, and amplitude permeability becomes low so that clearly from drawing 2. As a result of giving such the characteristic to the work-hardening part 53, the following effects are acquired in this embodiment.
[0033](1) In spite of having made small the cross-section area of the passage part 27, the flexural strength of the passage part 27 is maintained. Therefore, the intensity to the bending moment based on the centrifugal force F which acts on the rotor magnet 19 is secured. As mentioned above, the minimum width size w1 of the radial direction of the passage part 27 can be made smaller than the minimum width size W1 in the conventional technology 1 shown in drawing 8.
[0034]The intensity to the bending moment can also be made to increase further by adjustment of the width dimension of the passage part 27, or the grade of a compression set. As a result, the limit of a motor maximum engine speed can be raised about the intensity of the passage part 27.
[0035](2) Leak magnetic flux phib which the magnetic resistance of the passage part 27 was increasing by Reason for the following (a) - (c) as compared with the conventional technology 1, and was explained to drawing 8 as a result is decreasing conventionally. That is, amplitude permeability is falling by the (a) compression set, and magnetic resistance is increasing in inverse proportion to amplitude permeability. (b) It becomes thin meat by a compression set, the cross-section area of the passage part 27 is small, and magnetic resistance is increasing in inverse proportion to a cross-section area. (c) The opening 55 has produced between the rotor laminate sheets 51 by the compression set. Since the amplitude permeability of air is dramatically small, magnetic resistance is increasing by generating of an opening.
[0036]Only the composition of the stator container liner laminate sheet with which the motor of "Embodiment 2" book embodiment constitutes the stator container liner 37 to the motor of the above-mentioned conventional technology 2 is different.Then, explanation is omitted about the composition which is common in the conventional technology 2, and only a point of difference is explained.
[0037]Drawing 3 shows the composition of the stator container liner laminate sheet 61 of Embodiment 2. The figure (a) is a top view of the stator container liner laminate sheet 61, and expands and shows the portion equivalent to the circle B of drawing 6. And the shape of the stator container liner laminate sheet 61 seen from the direction of figure Nakaya seal Y is shown in the figure (b). The figure (b) shows the state where the stator container liner laminate sheet 61 was laminated.
[0038]And the work-hardening part 63 which performed compression-set processing is formed in a part of connecting part 45a, and the cross-section area of the connecting part 45a is set up smaller than the conventional technology 2. As shown in drawing 3 (a), the work-hardening part 63 is formed in the center of the connecting part 45a, and the range of the work-hardening part 63 is b at a circumferencial direction. As shown in drawing 3 (b), the minimum thickness of the work-hardening part 63 is t2, and is thinner than the thickness T2 of the general part of the stator container liner laminate sheet 61. And when the thickness of the work-hardening part 63 became thin, the opening 65 has produced between the stator container liner laminate sheets 61.
[0039]As Embodiment 1 explained drawing 2, in the work-hardening part 63, tensile strength is increasing from the general part of the stator container liner laminate sheet 61, and amplitude permeability becomes low. As a result of giving such the characteristic to the work-hardening part 63, the following effects are acquired in this embodiment.
[0040](1) In spite of having made small the minimum width size of the connecting part 45a, the flexural strength of the connecting part 45a is maintained. Therefore, the modification and destruction of the stator container liner 37 at the time of processing or press fit are avoided at the time of handling. As mentioned above, the minimum width size w2 of the radial direction of a passage part (connecting part 45a) can be made smaller than W2 in the conventional technology 2 of drawing 9.
[0041](2) The magnetic resistance of the connecting part 45a is increasing by Reason (a) - (c) explained to Embodiment 1 as compared with the conventional technology 2, and leak magnetic flux phid explained to drawing 9 is decreasing. The intensity to modification or destruction can also be further improved by grade adjustment of the width dimension of the connecting part 45a, or a compression set.
[0042]In the above, the suitable embodiment of this invention was described. Of course, this invention can be

applied also like a dynamo. It is applicable also like the rotating machine which makes only a rotor or a stator a layered product. A work-hardening part may not be restricted to the position shown in Embodiments 1 and 2, may be provided in other places of a passage part and a connecting part, and may be provided in a passage part and the whole connecting part.

[0043]In addition, in the composition inserted about Embodiment 2 without pressing the stator container liner 37 fit in the stator outer case 35, this invention is applicable similarly. When machining it into the inner circumference of the stator container liner 37 furthermore, this invention can be applied to the both sides when not carrying out.

[0044]

[Effect of the Invention]By having provided the work-hardening part between the magnetic poles of each laminate sheet, or in the passage part which connects a magnetic pole and other laminate sheet portions, in this work-hardening part, according to this invention, the two characteristics are changing simultaneously as the intensity to external force becomes high and amplitude permeability becomes high. Therefore, both the effects of securing the intensity of a passage part, and preventing modification and destruction, and reducing the leak magnetic flux from a passage part, and raising motor performance can be simultaneously done so.

[0045]In the laminate sheet which forms the magnetic pole layered product used for a rotor in one mode of this invention, By having provided the work-hardening part in the narrow portion (namely, passage part) between the shoulder of the opening for magnets, and a rotor periphery, The leak magnetic flux which the intensity of the passage part to the bending moment based on the centrifugal force which acts on a rotor magnet increases, and leaks from the magnetic pole of the outside of the opening for magnets to other laminate sheet portions through a passage part decreases.

[0046]In one mode of this invention, the leak magnetic flux which the intensity to the external force of a connecting part increases, and leaks to a connecting part decreases in the laminate sheet which forms the magnetic pole layered product used for a stator by having provided the work-hardening part in the narrow connecting part which connects between convex poles by the inner circumference side.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention]This invention relates to the magnetic pole layered product of a rotating machine, and the magnetic pole layered product of the rotating machine especially formed by being used for a rotor or a stator and laminating a laminate sheet.

[Translation done.]

PRIOR ART

[Description of the Prior Art]Conventionally, the magnetic pole layered product formed in the stator and rotor of a rotating machine (a motor or a dynamo) by laminating a laminate sheet is used. As a laminate sheet, the steel plate which consists of a charge of high magnetic permeability deadwood, for example is used. By this laminated structure, eddy current loss is stopped few. Hereafter, the motor provided with the stator and rotor of such a laminated structure is explained as conventional technology.
[0003]"Conventional technology 1" drawing 4 is a sectional view showing the composition of the motor used conventionally. This motor is provided with the rotor 3 interpolated in the stator 1 and the stator 1.
It is the inner magnet type permanent magnet motor which provided the permanent magnet in the rotor 3.

[0004]The stator body 5 of the stator 1 laminates the stator laminate sheet 7 of the ring form of about 0.5 mm of board thickness, and is formed in the shape of a cartridge. As it projects to the inner circumference side, the six convex poles 9 are formed in the stator body 5. The six convex poles 9 are formed at equal intervals, and are respectively formed in the stator body 5 at one. The inner skin of each convex pole 9 is a cylinder side, and is set up separate a fixed crevice from the peripheral face of the rotor 3, and counter. The stator coil is formed by winding the stator winding 11 around each convex pole 9 like a graphic display.
[0005]The rotor body 13 of the rotor 3 laminates the rotor laminate sheet 15 of the ring form of about 0.5 mm of board thickness, and is formed in cylindrical shape. The axis of rotation 17 is fixed in the center of the rotor body 13, and this axis of rotation 17 is supported pivotally by the motor case which is not illustrated. The rotor magnet 19 is being fixed to two places (position which shifted the phase about 180 degrees) which face near the peripheral face of the rotor body 13 each other on both sides of a center. And the portion by the side of the periphery of the rotor magnet 19 in the rotor body 13 serves as the magnetic pole 21. That is, the magnetic flux produced in the rotor magnet 19 goes in and out from the rotor 3 through the magnetic pole 21.
[0006]Drawing 5 is a top view of the rotor laminate sheet 15. The axial circular attaching hole 23 for inserting the axis of rotation 17 is formed in the center of the rotor laminate sheet 15. The opening 25 for magnets of the rectangle for inserting the rotor magnet 19 is formed near the peripheral face of the rotor laminate sheet 15. The periphery side of the opening 25 for magnets is the magnetic pole 21a. This magnetic pole 21a is laminated and the magnetic pole 21 of the above-mentioned rotor body 13 is formed. Here, let the narrow portion between the shoulder of the opening 25 for magnets, and a rotor periphery be the passage part 27. The passage part 27 is a portion which connects the magnetic pole 21a and other rotor laminate sheet 15 portions.
[0007]The composition of the conventional motor shown in drawing 4 was explained above. A revolving magnetic field occurs by supplying alternating current to the stator winding 11 at the time of operation of a motor. On the other hand with the rotor 3, a magnetic field occurs in the magnetic pole 21 with the rotor magnet 19. By the magnetic action of the revolving magnetic field of the stator 1, and the magnetic field of the rotor 3, torque acts on the rotor 3 and the rotor 3 rotates.
[0008]"Conventional technology 2" drawing 6 is a sectional view showing the composition of the motor of the conventional technology 2. In this motor, the composition of the stator body 33 in the stator 31 differs from the conventional technology 1. The stator body 33 is block construction and consists of the stator outer case 35 and the stator container liner 37 inserted in this stator outer case 35 without the crevice.
[0009]The stator outer case 35 laminates the stator outer case laminate sheet 39 of the ring form of about 0.5 mm of board thickness, and is formed in cylindrical shape. The stator container liner 37 also laminates the stator container liner laminate sheet 41 of the ring form of about 0.5 mm of board thickness, and is formed in the shape of a cartridge. The six convex poles 43 are formed in the hoop direction at equal intervals at the stator container liner 37. And the ****** convex pole 43 is connected by the connecting part 45 by the inner circumference side. The inner skin (namely, inner skin of the pipe formed of the convex pole 43 and the connecting part 45) of the stator container liner 37 is a cylinder side, and is set up separate a fixed crevice from the peripheral face of the rotor 3, and counter. The peripheral face (namely, field of the outside of each convex pole 43) of the stator container liner 37 is also a cylinder side. The stator container liner 37 is pressed fit in the stator outer case 35, and each convex pole 43 has stuck it without the stator outer case 35 and a crevice. By abolishing the crevice

between the convex pole 43 and the stator outer case 35, it is easy to pass along magnetic flux among both.
[0010]Drawing 7 is a top view of the stator container liner laminate sheet 41. The six convex poles 43a are connected by the connecting part 45a corresponding to the sectional shape of the stator container liner 37. This convex pole 43a and connecting part 45a are laminated, and the above-mentioned convex pole 43 and the connecting part 45 of the stator container liner 37 are formed respectively. The connecting part 45a is a passage part which connects between the ****** convex poles 43a.
[0011]In the case of the motor of drawing 6, before inserting the stator container liner 37 in the stator outer case 35, the stator winding 11 can be twisted around the convex pole 43. Since the stator winding 11 is twisted from the outside, it twists from the case where it twists from the inside like the conventional technology 1, and work is easy. And the share of the stator winding 11 in the space between convex poles can be raised, and the number of turns of a stator coil can be increased.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention]In this invention, the work-hardening part was provided between the magnetic poles of each laminate sheet, or in the passage part which connects a magnetic pole and other laminate sheet portions. Therefore, in this work-hardening part, the two characteristics are changing simultaneously as the intensity to external force becomes high and amplitude permeability becomes high.
Therefore, both the effects of securing the intensity of a passage part, and preventing modification and destruction, and reducing the leak magnetic flux from a passage part, and raising motor performance can be simultaneously done so.
[0045]In the laminate sheet which forms the magnetic pole layered product used for a rotor in one mode of this invention, By having provided the work-hardening part in the narrow portion (namely, passage part) between the shoulder of the opening for magnets, and a rotor periphery, The leak magnetic flux which the intensity of the passage part to the bending moment based on the centrifugal force which acts on a rotor magnet increases, and leaks from the magnetic pole of the outside of the opening for magnets to other laminate sheet portions through a passage part decreases.
[0046]In one mode of this invention, the leak magnetic flux which the intensity to the external force of a connecting part increases, and leaks to a connecting part decreases in the laminate sheet which forms the magnetic pole layered product used for a stator by having provided the work-hardening part in the narrow connecting part which connects between convex poles by the inner circumference side.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]

[Translation done.]

MEANS

[Means for Solving the Problem]In a magnetic pole layered product of a rotating machine formed by laminating, this invention a laminate sheet each laminate sheet, On a circumference, it consists of a disk or ring form which forms a magnetic pole of a predetermined number, and is connected between magnetic poles or with a magnetic pole and a passage part with a laminate sheet portion narrow in addition to this, and a work-hardening part by this passage part compression set is provided.
[0022]According to the above, between magnetic poles of each laminate sheet is connected with a passage part, or a magnetic pole of each laminate sheet and other laminate sheet portions are connected with a passage part. And a work-hardening part by a compression set is provided in this passage part. a passage part may all boil a work-hardening part, it may be provided, and may be provided in part. In this work-hardening part, intensity to external force is high by a compression set, and amplitude permeability becomes high, and magnetic resistance is increasing.
[0023]This magnetic pole layered product is used for a rotor interpolated in a stator of a rotating machine in one mode of this invention, and to said laminate sheet. An opening for magnets for inserting a rotor magnet is provided near a rotor periphery, said magnetic pole is formed in the outside of this opening for magnets, and said passage part is a narrow portion between a shoulder of said opening for magnets, and a rotor periphery.
[0024]The above is the gestalt which applied this invention to a rotor of a rotating machine. A magnetic pole is formed in the outside of an opening for magnets of a laminate sheet. And a narrow portion between a shoulder of an opening for magnets and a rotor periphery serves as a passage part which connects a magnetic pole and other laminate sheet portions. A work-hardening part is provided in this passage part.
[0025]In one mode of this invention, said magnetic pole layered product is used for a stator of a rotating machine, said laminate sheet arranges annularly two or more convex poles for winding stator winding, and is formed in ring form, and said passage part is a narrow connecting part which connects between said convex poles by the inner circumference side.
[0026]The above is the gestalt which applied this invention to a stator of a rotating machine. In each laminate sheet, a connecting part is provided so that between ****** convex poles may be connected by the inner circumference side, and this connecting part is a passage part which connects between magnetic poles. And a work-hardening part is provided in this passage part.
[0027]
[Embodiment of the Invention]Hereafter, an embodiment of the invention is described based on Drawings. Since the element which attached the numerals given to the element shown in above-mentioned drawing 4 - drawing 9 and identical codes has the same function, explanation is omitted.
[0028]Only the composition of the rotor laminate sheet with which the motor of "Embodiment 1" book embodiment constitutes the rotor 3 to the motor of the above-mentioned conventional technology 1 is different. Then, explanation is omitted about the composition which is common in the conventional technology 1, and only a point of difference is explained.
[0029]Drawing 1 shows the composition of the rotor laminate sheet 51 of Embodiment 1. The figure (a) is a top view of the rotor laminate sheet 51, and expands and shows the portion equivalent to the circle A of drawing 4. And the shape of the rotor laminate sheet 51 seen from the arrow X direction in drawing 1 (a) is shown in the figure (b). The figure (b) shows the state where the rotor laminate sheet 51 was laminated.
[0030]As shown in drawing 1 (a), in the rotor laminate sheet 51 of this embodiment, the work-hardening part 53 which performed compression-set processing is formed in a part of passage part 27, and the cross-section area of the portion is set up smaller than conventional technology. As shown in drawing 1 (a), the work-hardening part 53 is formed centering on the shoulder corner of the opening 25 for magnets, and the range of the work-hardening part 53 is B at a circumferencial direction. As shown in drawing 1 (b), the minimum thickness of the work-hardening part 53 is t1, and is thinner than the thickness T1 of the general part of the rotor laminate sheet 51. And since the thickness of the work-hardening part 53 is thinner than a general part, the opening 55 has produced between the rotor laminate sheets 51.
[0031]The characteristic change of the steel plate for rotor laminate sheet 51 by drawing 2 performing

compression-set processing is shown. The figure shows the characteristic at the time of performing cold rolling working as compression-set processing. In the figure, a horizontal axis is a deformation degree (degree of modification by compression-set processing), and a vertical axis is the tensile strength and amplitude permeability of a steel plate. Tensile strength is increasing, so that a deformation degree increases, as shown in the figure. The increase in tensile strength is based on work hardening at the time of a compression set. Amplitude permeability is falling, so that a deformation degree increases. Thus, the two characteristics of tensile strength and amplitude permeability can be simultaneously changed by performing compression-set processing.
[0032]In the work-hardening part 53, tensile strength is increasing from the general part of the rotor laminate sheet 51, and amplitude permeability becomes low so that clearly from drawing 2. As a result of giving such the characteristic to the work-hardening part 53, the following effects are acquired in this embodiment.
[0033](1) In spite of having made small the cross-section area of the passage part 27, the flexural strength of the passage part 27 is maintained. Therefore, the intensity to the bending moment based on the centrifugal force F which acts on the rotor magnet 19 is secured. As mentioned above, the minimum width size w1 of the radial direction of the passage part 27 can be made smaller than the minimum width size W1 in the conventional technology 1 shown in drawing 8.
[0034]The intensity to the bending moment can also be made to increase further by adjustment of the width dimension of the passage part 27, or the grade of a compression set. As a result, the limit of a motor maximum engine speed can be raised about the intensity of the passage part 27.
[0035](2) Leak magnetic flux phib which the magnetic resistance of the passage part 27 was increasing by Reason for the following (a) - (c) as compared with the conventional technology 1, and was explained to drawing 8 as a result is decreasing conventionally. That is, amplitude permeability is falling by the (a) compression set, and magnetic resistance is increasing in inverse proportion to amplitude permeability. (b) It becomes thin meat by a compression set, the cross-section area of the passage part 27 is small, and magnetic resistance is increasing in inverse proportion to a cross-section area. (c) The opening 55 has produced between the rotor laminate sheets 51 by the compression set. Since the amplitude permeability of air is dramatically small, magnetic resistance is increasing by generating of an opening.
[0036]Only the composition of the stator container liner laminate sheet with which the motor of "Embodiment 2" book embodiment constitutes the stator container liner 37 to the motor of the above-mentioned conventional technology 2 is different.Then, explanation is omitted about the composition which is common in the conventional technology 2, and only a point of difference is explained.
[0037]Drawing 3 shows the composition of the stator container liner laminate sheet 61 of Embodiment 2. The figure (a) is a top view of the stator container liner laminate sheet 61, and expands and shows the portion equivalent to the circle B of drawing 6. And the shape of the stator container liner laminate sheet 61 seen from the direction of figure Nakaya seal Y is shown in the figure (b). The figure (b) shows the state where the stator container liner laminate sheet 61 was laminated.
[0038]And the work-hardening part 63 which performed compression-set processing is formed in a part of connecting part 45a, and the cross-section area of the connecting part 45a is set up smaller than the conventional technology 2. As shown in drawing 3 (a), the work-hardening part 63 is formed in the center of the connecting part 45a, and the range of the work-hardening part 63 is b at a circumferencial direction. As shown in drawing 3 (b), the minimum thickness of the work-hardening part 63 is t2, and is thinner than the thickness T2 of the general part of the stator container liner laminate sheet 61. And when the thickness of the work-hardening part 63 became thin, the opening 65 has produced between the stator container liner laminate sheets 61.
[0039]As Embodiment 1 explained drawing 2, in the work-hardening part 63, tensile strength is increasing from the general part of the stator container liner laminate sheet 61, and amplitude permeability becomes low. As a result of giving such the characteristic to the work-hardening part 63, the following effects are acquired in this embodiment.
[0040](1) In spite of having made small the minimum width size of the connecting part 45a, the flexural strength of the connecting part 45a is maintained. Therefore, the modification and destruction of the stator container liner 37 at the time of processing or press fit are avoided at the time of handling. As mentioned above, the minimum width size w2 of the radial direction of a passage part (connecting part 45a) can be made smaller than W2 in the conventional technology 2 of drawing 9.
[0041](2) The magnetic resistance of the connecting part 45a is increasing by Reason (a) - (c) explained to Embodiment 1 as compared with the conventional technology 2, and leak magnetic flux phid explained to drawing 9 is decreasing. The intensity to modification or destruction can also be further improved by grade adjustment of the width dimension of the connecting part 45a, or a compression set.
[0042]In the above, the suitable embodiment of this invention was described. Of course, this invention can be applied also like a dynamo. It is applicable also like the rotating machine which makes only a rotor or a stator a layered product. A work-hardening part may not be restricted to the position shown in Embodiments 1 and 2, may be provided in other places of a passage part and a connecting part, and may be provided in a passage part

and the whole connecting part.

[0043]In addition, in the composition inserted about Embodiment 2 without pressing the stator container liner 37 fit in the stator outer case 35, this invention is applicable similarly. When machining it into the inner circumference of the stator container liner 37 furthermore, this invention can be applied to the both sides when not carrying out.

[Translation done.]

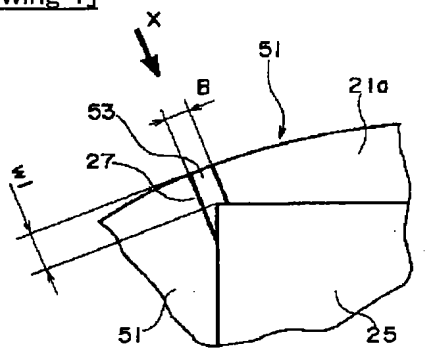
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is an explanatory view showing the shape of the rotor laminate sheet of the motor of a 1st embodiment of this invention.
[Drawing 2]It is an explanatory view showing change of the characteristic by compression-set processing of a laminate sheet.
[Drawing 3]It is an explanatory view showing the shape of the stator laminate sheet of the motor of a 2nd embodiment of this invention.
[Drawing 4]It is a sectional view showing the composition of the motor of the conventional technology 1.
[Drawing 5]It is a top view of the rotor laminate sheet of the motor of drawing 4.
[Drawing 6]It is a sectional view showing the composition of the motor of the conventional technology 2.
[Drawing 7]It is a top view of the stator container liner laminate sheet of the motor of drawing 6.
[Drawing 8]It is a detail view of the portion of the circle A of the motor of drawing 4.
[Drawing 9]It is a detail view of the portion of the circle B of the motor of drawing 6.
[Description of Notations]
1 and 31 A stator and 3 A rotor, 5, 33 stator bodies, and 9, 43 and 43a Convex pole, 11 stator windings, 13 rotor bodies, and 15 and 51 Rotor laminate sheet, 19 A rotor magnet, and 21 and 21a A stator container liner, and 41 and 61 A connecting part, and 53 and 63 A work-hardening part, and 55 and 65 [A magnetic pole and 25] [The opening for magnets 27 passage parts, and 35] [A stator outer case and 37] [A stator container liner laminate sheet and 45 and 45a] [Opening.]

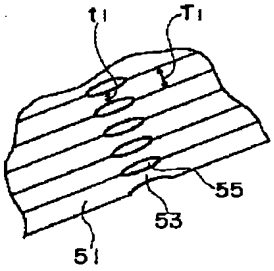
DRAWINGS

[Drawing 1]

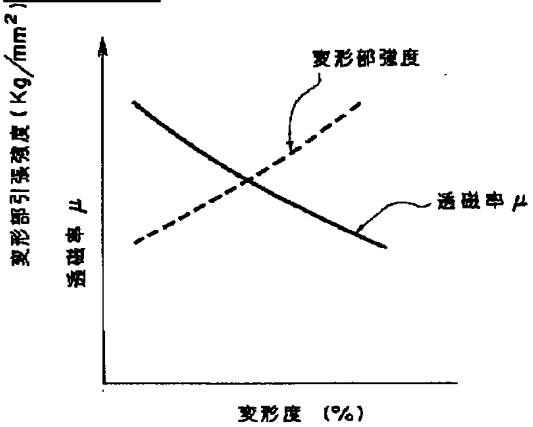
(a)



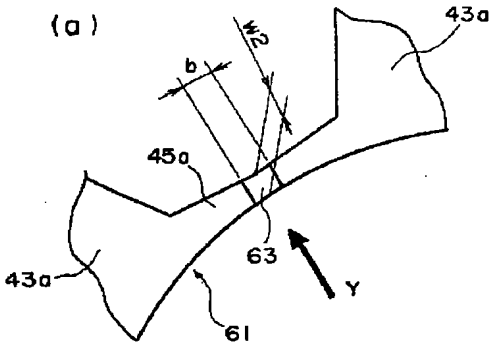
(b)

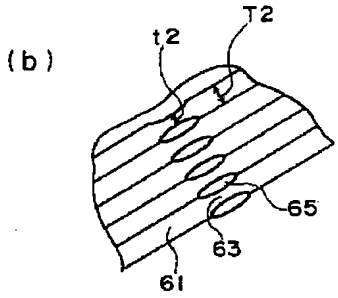


[Drawing 2]

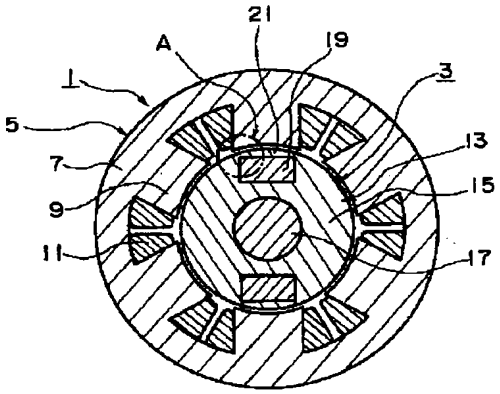


[Drawing 3]

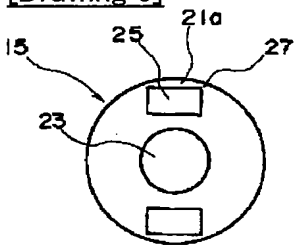




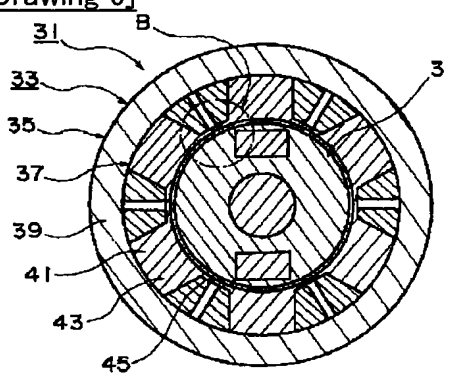
[Drawing 4]



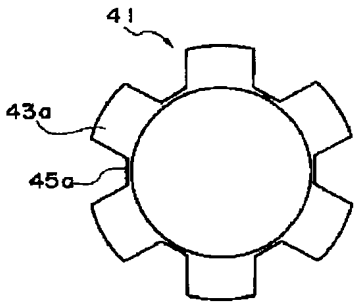
[Drawing 5]



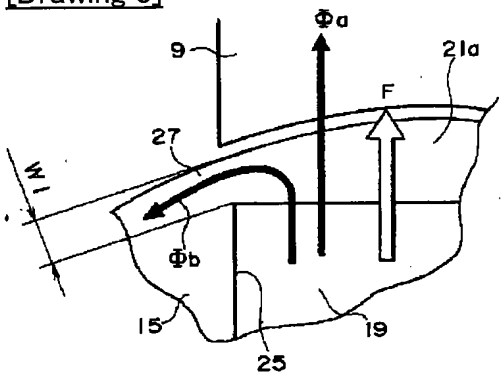
[Drawing 6]



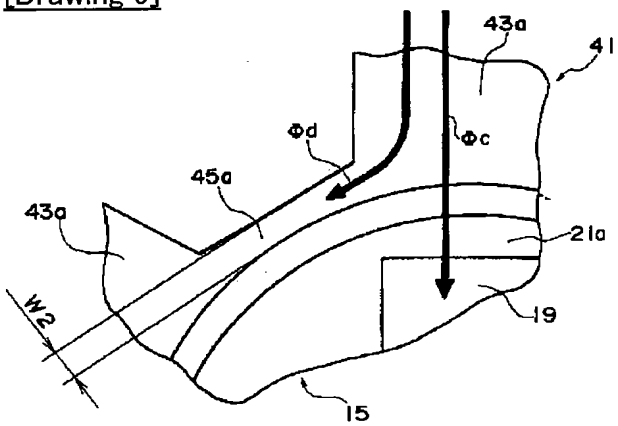
[Drawing 7]



[Drawing 8]



[Drawing 9]



[Translation done.]

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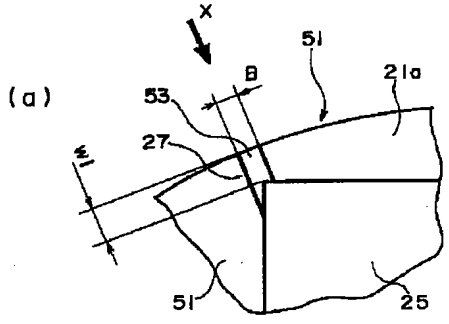
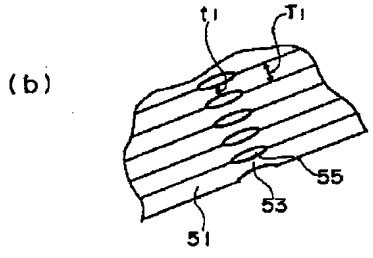
(54)【発明の名称】　回転機の磁極積層体

(57)【要約】

【課題】　渡り部から磁束がもれるのでモータ性能が低下する。また渡り部の強度の確保が難しい。

【解決手段】　積層板を積層して形成される回転機の磁極積層体において、各積層板５１は、周上に所定数の磁極を形成する円板またはリング形状からなり、磁極間、または磁極とその他積層板部分が幅狭の渡り部で結ばれている。そして渡り部に圧縮変形による加工硬化部が設けられている。この磁極積層体はロータに用いられ、この場合、積層板５１の渡り部２７は磁石用開口部２５の肩部とロータ外周の間の幅狭の部分である。また磁極積層体は、ステータに用いられ、この場合、積層板の渡り部は凸極間を内周側で連結する幅狭の連結部である。





1

【特許請求の範囲】
【請求項１】　積層板を積層して形成される回転機の磁極積層体において、
各積層板は、周上に所定数の磁極を形成する円板またはリング形状からなり、磁極間、または磁極とその他積層板部分が幅狭の渡り部で結ばれており、該渡り部に圧縮変形による加工硬化部が設けられていることを特徴とする回転機の磁極積層体。
【請求項２】　請求項１に記載の回転機の磁極積層体において、
該磁極積層体は、回転機のステータに内挿されるロータに用いられ、
前記積層板には、ロータ外周付近にロータ磁石を嵌入するための磁石用開口部が設けられ、前記磁極を該磁石用開口部の外側に形成し、
前記渡り部は、前記磁石用開口部の肩部とロータ外周の間の幅狭の部分であることを特徴とする回転機の磁極積層体。
【請求項３】　請求項１に記載の回転機の磁極積層体において、
前記磁極積層体は、回転機のステータに用いられ、
前記積層板は、ステータ巻線を巻回するための複数の凸極を環状に配置してリング形状に形成され、
前記渡り部は、前記凸極間を内周側で連結する幅狭の連結部であることを特徴とする回転機の磁極積層体。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、回転機の磁極積層体、特に、ロータやステータに用いられ、積層板を積層して形成される回転機の磁極積層体に関する。
【０００２】
【従来の技術】従来、回転機（モータまたは発電機）のステータやロータに、積層板を積層して形成された磁極積層体が用いられている。積層板としては、例えば高透磁力材料からなる鋼板が用いられる。この積層構造により、うず電流損を少なく抑えている。以下、従来技術として、このような積層構造のステータおよびロータを備えたモータについて説明する。
【０００３】「従来技術１」図４は、従来より用いられているモータの構成を示す断面図である。このモータは、ステータ１と、ステータ１に内挿されたロータ３を備えており、ロータ３に永久磁石を設けた内磁型の永久磁石モータである。
【０００４】ステータ１のステータ本体５は、板厚０．５ミリ程度のリング形状のステータ積層板７を積層して筒形状に形成されている。ステータ本体５には、内周側に突出すようにして６個の凸極９が設けられている。６個の凸極９は等間隔に設けられており、各々ステータ本体５に一体に形成されている。各凸極９の内周面は円筒面であり、ロータ３の外周面と一定の隙間を隔てて対向

2

するように設定されている。各凸極９に図示の如くステータ巻線１１が巻回されることによりステータコイルが形成されている。
【０００５】ロータ３のロータ本体１３は、板厚０．５ミリ程度のリング形状のロータ積層板１５を積層して円筒形状に形成されている。ロータ本体１３の中央には回転軸１７が固定され、この回転軸１７は図示しないモータケースに軸支されている。また、ロータ本体１３の外周面付近には、中心をはさんで向き合う２箇所（１８０度位相をずらした位置）にロータ磁石１９が固定されている。そして、ロータ本体１３におけるロータ磁石１９の外周側の部分が磁極２１となっている。すなわち、ロータ磁石１９に生じる磁束は、磁極２１を通ってロータ３から出入する。
【０００６】図５は、ロータ積層板１５の平面図である。ロータ積層板１５の中央には、回転軸１７を嵌入するための円形の軸取付穴２３が設けられている。また、ロータ積層板１５の外周面付近には、ロータ磁石１９を嵌入するための長方形の磁石用開口部２５が設けられている。磁石用開口部２５の外周側は磁極２１ａである。この磁極２１ａが積層されて、前述のロータ本体１３の磁極２１が形成されている。ここで、磁石用開口部２５の肩部とロータ外周の間の幅狭の部分を渡り部２７とする。渡り部２７は、磁極２１ａとその他のロータ積層板１５部分とを結ぶ部分である。
【０００７】以上に図４に示した従来のモータの構成を説明した。モータの運転時、ステータ巻線１１に交流電流を供給することにより、回転磁界が発生する。一方ロータ３では、ロータ磁石１９により磁極２１に磁界が発生する。ステータ１の回転磁界とロータ３の磁界の磁気作用によってロータ３に回転力が作用し、ロータ３が回転する。
【０００８】「従来技術２」図６は、従来技術２のモータの構成を示す断面図である。このモータでは、ステータ３１におけるステータ本体３３の構成が従来技術１と異なっている。ステータ本体３３は分割構造であり、ステータ外筒３５と、このステータ外筒３５に隙間なくはめ込まれたステータ内筒３７とからなる。
【０００９】ステータ外筒３５は、板厚０．５ミリ程度のリング形状のステータ外筒積層板３９を積層して円筒形状に形成されている。ステータ内筒３７も板厚０．５ミリ程度のリング形状のステータ内筒積層板４１を積層して筒形状に形成されている。ステータ内筒３７には、周方向に等間隔に６個の凸極４３が設けられている。そして、連結部４５により、隣合う凸極４３が内周側で連結されている。ステータ内筒３７の内周面（すなわち凸極４３および連結部４５により形成される筒の内周面）は円筒面であり、ロータ３の外周面と一定の隙間を隔てて対向するように設定されている。また、ステータ内筒３７の外周面（すなわち各凸極４３の外側の面）も円筒

面である。ステータ内筒３７はステータ外筒３５に圧入されており、各凸極４３がステータ外筒３５と隙間なく密着している。凸極４３とステータ外筒３５の間の隙間をなくすことにより、両者の間に磁束が通りやすくなっている。

【００１０】図７は、ステータ内筒積層板４１の平面図である。ステータ内筒３７の断面形状に対応して、６個の凸極４３ａが連結部４５ａにより連結されている。この凸極４３ａおよび連結部４５ａが積層されて、各々前述のステータ内筒３７の凸極４３および連結部４５が形成されている。連結部４５ａは、隣合う凸極４３ａの間を結ぶ渡り部である。

【００１１】図６のモータの場合、ステータ内筒３７をステータ外筒３５にはめ込む前にステータ巻線１１を凸極４３に巻きつけることができる。ステータ巻線１１を外側から巻き付けるので、従来技術１のように内側から巻き付ける場合より巻付け作業が容易である。そして、凸極間の空間におけるステータ巻線１１の占有率を高めてステータコイルの巻数を増やすことができる。

【００１２】

【発明が解決しようとする課題】

「従来技術１についての課題」図８は、図４に円で示したＡ部分の詳細を示している。渡り部２７の半径方向の最小幅寸法は図示のようにＷ１である。

【００１３】図８には、ロータ磁石１９から磁極２１ａを通り凸極９に至る磁束Φａが矢印で示されている。磁束Φａの一部は凸極９に届かずに、もれ磁束Φｂとなって渡り部２７からロータ積層板１５の他の部分にもれている。磁極２１ａと凸極９の間に効率よく磁束を通してモータの性能を向上させるためには、もれ磁束Φｂを極力低減することが好ましい。ここで、磁石用開口部２５をより外周側に配置して渡り部２７の半径方向の幅を狭くすることで、効果的にもれ磁束を低減することができる。すなわち、渡り部２７の半径方向Ｗ１の幅を狭くすると、断面積の低減により渡り部２７の磁気抵抗が増すので、もれ磁束Φｂが低減する。

【００１４】一方、ロータ３が回転すると、図示の如く、ロータ磁石１９に遠心力Ｆが作用する。遠心力Ｆにより、渡り部２７に曲げモーメントが作用する。従って曲げモーメントによって亀裂や破壊が生じないように、渡り部２７の半径方向の幅を設定する必要がある。また、遠心力Ｆはロータ回転数の２乗に比例して増大するので、ロータ回転数に応じて渡り部２７に作用する曲げモーメントも大きくなる。従って、モータの最高回転数が、渡り部２７の曲げ強度（すなわち幅寸法）により制限される。

【００１５】以上より、従来のモータでは、モータの性能向上のために渡り部２７の半径方向の幅を狭くしてもれ磁束Φｂを低減することが好ましいが、曲げ強度確保のためには渡り部２７の幅を狭くすることは難しい。

【００１６】「従来技術２についての課題」図９は、図６に円で示したＢ部分の詳細を示している。連結部４５ａの半径方向の最小幅寸法は図示のようにＷ２である。

【００１７】図９には、凸極４３ａから磁極２１ａに至る磁束Φｃが矢印で示されている。磁束Φｃの一部は磁極２１ａに届かずに、もれ磁束Φｄとなって連結部４５ａにもれている。ここでも、前述と同様、凸極４３ａと磁極２１ａの間に効率よく磁束を通してモータの性能を向上させるためには、連結部４５ａの半径方向の幅を狭くしてもれ磁束Φｄを極力低減することが効果的である。

【００１８】一方、（１）モータ製造時、ステータ内筒３７の取扱い中に連結部４５に亀裂や破壊が生じるのを防止する必要がある。（２）また、ステータ１とロータ３の隙間を小さくしてモータの性能を向上させるため、ステータ内筒３７の内周面を機械加工にて仕上げる場合がある。この場合、機械加工時による連結部４５の変形を防ぐ必要がある。（３）さらにまた、前述のように、ステータ内筒３７をステータ外筒３５に圧入するように構成した場合、ステータ内筒３７の円環剛性を確保して変形を防ぐ必要がある。また圧入により連結部４５に曲げモーメントが作用するので、圧入時に連結部４５に亀裂や破壊が発生するのを防ぐ必要がある。各ステータ積層板４１の連結部４５ａの半径方向の幅は、（１）～（３）の要求に応えるようにある程度広く設定されている。

【００１９】以上より、従来技術２のモータでは、モータの性能向上のためには連結部４５ａの半径方向の幅を狭くしてもれ磁束Φｄを低減することが好ましい。しかしながら、連結部４５ａの亀裂や破壊を防ぎ、圧入時のステータ内筒３７の変形を防ぐ必要があるので連結部４５ａの幅を狭くすることは難しい。

【００２０】「本発明の目的」本発明は、上記の課題を解決するためになされたもので、積層板を積層して形成され、この積層板の周上に磁極を形成するような磁極積層体に関する。本発明の目的は、各積層板の磁極間の渡り部、または磁極とその他の磁極積層体部分の渡り部の外力に対する強度を向上させるとともに、上記渡り部の磁気抵抗を高めて磁束のもれを低減することが可能な磁極積層体を提供することにある。そして、渡り部の強度を確保して変形や破壊を防止することと、もれ磁束を低減してモータ性能を向上することとを両立させることを目的とする。

【００２１】

【課題を解決するための手段】本発明は、積層板を積層して形成される回転機の磁極積層体において、各積層板は、周上に所定数の磁極を形成する円板またはリング形状からなり、磁極間、または磁極とその他積層板部分が幅狭の渡り部で結ばれており、該渡り部圧縮変形による加工硬化部が設けられている。

【００２２】上記によれば、各積層板の磁極間が渡り部で結ばれ、または各積層板の磁極とその他の積層板部分が渡り部で結ばれている。そしてこの渡り部に圧縮変形による加工硬化部が設けられている。加工硬化部は渡り部の全部に設けてもよく一部に設けてもよい。この加工硬化部では、圧縮変形により外力に対する強度が高くなっており、かつ透磁率が高くなって磁気抵抗が増している。

【００２３】本発明の一態様では、該磁極積層体は、回転機のステータに内挿されるロータに用いられ、前記積層板には、ロータ外周付近にロータ磁石を嵌入するための磁石用開口部が設けられ、前記磁極を該磁石用開口部の外側に形成し、前記渡り部は、前記磁石用開口部の肩部とロータ外周の間の幅狭の部分である。

【００２４】上記は、本発明を回転機のロータに適用した形態である。積層板の磁石用開口部の外側に磁極が形成されている。そして、磁石用開口部の肩部とロータ外周の間の幅狭の部分が、磁極とその他の積層板部分を結ぶ渡り部となっている。この渡り部に加工硬化部が設けられている。

【００２５】また、本発明の一態様では、前記磁極積層体は、回転機のステータに用いられ、前記積層板は、ステータ巻線を巻回するための複数の凸極を環状に配置してリング形状に形成され、前記渡り部は、前記凸極間を内周側で連結する幅狭の連結部である。

【００２６】上記は、本発明を回転機のステータに適用した形態である。各積層板において、隣合う凸極の間を内周側で連結するように連結部が設けられ、この連結部が磁極間を結ぶ渡り部である。そして、この渡り部に加工硬化部が設けられている。

【００２７】

【発明の実施の形態】以下、本発明の実施の形態を図面に基づいて説明する。なお、前述の図４～図９に示す要素に付した符号と同一符号を付した要素は同一機能を有するので、説明を省略する。

【００２８】「実施形態１」本実施形態のモータは、前述の従来技術１のモータに対して、ロータ３を構成するロータ積層板の構成のみが相違している。そこで、従来技術１と共通する構成については説明を省略し、相違点についてのみ説明する。

【００２９】図１は、実施形態１のロータ積層板５１の構成を示している。同図（ａ）は、ロータ積層板５１の平面図であって、図４の円Ａに相当する部分を拡大して示している。そして図１（ａ）中の矢印Ｘ方向から見たロータ積層板５１の形状が同図（ｂ）に示されている。同図（ｂ）は、ロータ積層板５１を積層した状態を示している。

【００３０】図１（ａ）に示すように、本実施形態のロータ積層板５１では、渡り部２７の一部に、圧縮変形処理を施した加工硬化部５３が設けられており、その部分の断面積は従来技術より小さく設定されている。図１（ａ）に示すように、加工硬化部５３は磁石用開口部２５の肩部隅を中心に設けられており、加工硬化部５３の範囲は円周方向にＢである。また図１（ｂ）に示すように、加工硬化部５３の最小肉厚はｔ１であり、ロータ積層板５１の一般部の肉厚Ｔ１よりも薄くなっている。そして、加工硬化部５３の肉厚が一般部より薄いので、ロータ積層板５１間に空隙５５が生じている。

【００３１】図２は、圧縮変形処理を施すことによる、ロータ積層板５１用の鋼板の特性変化を示している。同図は、圧縮変形処理として冷間圧延加工を施した場合の特性を示している。同図において、横軸は変形度（圧縮変形処理による変形の度合い）であり、縦軸は鋼板の引張強度および透磁率である。同図に示すように、変形度が増すほど引張強度が増している。引張強度の増加は、圧縮変形時の加工硬化に基づくものである。また、変形度が増すほど透磁率が低下している。このように、圧縮変形処理を施すことにより、引張強度と透磁率という２つの特性を同時に変化させることができる。

【００３２】図２から明らかなように、加工硬化部５３では、ロータ積層板５１の一般部より引張強度が増しており、かつ透磁率が低くなる。加工硬化部５３にこのような特性を与えた結果、本実施形態では以下のような効果が得られている。

【００３３】（１）渡り部２７の断面積を小さくしたにもかかわらず、渡り部２７の曲げ強度が維持されている。従って、ロータ磁石１９に作用する遠心力Ｆに基づく曲げモーメントに対しての強度が確保されている。以上より、渡り部２７の半径方向の最小幅寸法ｗ１を図８に示した従来技術１における最小幅寸法Ｗ１よりも小さくすることができる。

【００３４】なお、渡り部２７の幅寸法や圧縮変形の程度の調整により、さらに曲げモーメントに対する強度を増加させることもできる。その結果、渡り部２７の強度に関して、モータ最高回転数の限界を高めることができる。

【００３５】（２）渡り部２７の磁気抵抗が下記理由（ａ）～（ｃ）により従来技術１と比較して増加しており、その結果、図８に説明したもれ磁束Φｂが従来よりも低減している。すなわち、（ａ）圧縮変形により透磁率が低下しており、磁気抵抗は透磁率に反比例して増加している。（ｂ）圧縮変形により薄肉になり渡り部２７の断面積が小さくなっており、断面積に反比例して磁気抵抗が増加している。（ｃ）圧縮変形によりロータ積層板５１の間に空隙５５が生じている。空気の透磁率は非常に小さいので、空隙の発生により磁気抵抗が増加している。

【００３６】「実施形態２」本実施形態のモータは、前述の従来技術２のモータに対して、ステータ内筒３７を構成するステータ内筒積層板の構成のみが相違してい

る。そこで、従来技術２と共通する構成については説明を省略し、相違点についてのみ説明する。

【００３７】図３は、実施形態２のステータ内筒積層板６１の構成を示している。同図（ａ）は、ステータ内筒積層板６１の平面図であって、図６の円Ｂに相当する部分を拡大して示している。そして図中矢印Ｙ方向から見たステータ内筒積層板６１の形状が同図（ｂ）に示されている。同図（ｂ）は、ステータ内筒積層板６１を積層した状態を示している。

【００３８】そして連結部４５ａの一部に、圧縮変形処理を施した加工硬化部６３が設けられており、連結部４５ａの断面積は従来技術２より小さく設定されている。図３（ａ）に示すように、加工硬化部６３は連結部４５ａの中央に設けられており、加工硬化部６３の範囲は円周方向にｂである。また図３（ｂ）に示すように、加工硬化部６３の最小肉厚はｔ２であり、ステータ内筒積層板６１の一般部の肉厚Ｔ２よりも薄くなっている。そして、加工硬化部６３の肉厚が薄くなったことによりステータ内筒積層板６１間に空隙６５が生じている。

【００３９】実施形態１にて図２について説明したのと同様に、加工硬化部６３では、ステータ内筒積層板６１の一般部より引張強度が増しており、かつ透磁率が低くなる。加工硬化部６３にこのような特性を与えた結果、本実施形態では以下のような効果が得られている。

【００４０】（１）連結部４５ａの最小幅寸法を小さくしたにもかかわらず、連結部４５ａの曲げ強度が維持されている。従って、取扱い時、加工時あるいは圧入時のステータ内筒３７の変形や破壊が回避されている。以上より、渡り部（連結部４５ａ）の半径方向の最小幅寸法ｗ２を図９の従来技術２におけるＷ２よりも小さくすることができる。

【００４１】（２）連結部４５ａの磁気抵抗が、実施形態１に説明した理由（ａ）～（ｃ）により従来技術２と比較して増加しており、図９に説明したもれ磁束Φｄが低減している。なお、連結部４５ａの幅寸法や圧縮変形の程度調整により、さらに変形や破壊に対する強度を向上することもできる。

【００４２】以上、本発明の好適な実施形態について説明した。なお、本発明を発電機にも同様に適用可能なことはもちろんである。また、ロータのみ、あるいはステータのみを積層体とする回転機にも同様に適用可能である。また、加工硬化部は、実施形態１、２に示した位置に限られず、渡り部、連結部の他の場所に設けてもよく、また渡り部、連結部の全体に設けてもよい。

【００４３】その他、実施形態２に関し、ステータ内筒３７をステータ外筒３５に圧入せずに嵌入する構成においても本発明を同様に適用できる。さらにステータ内筒３７の内周に機械加工を行う場合、行わない場合の双方に本発明を適用できる。

【００４４】

【発明の効果】本発明によれば、各積層板の磁極間、または磁極とその他の積層板部分を結ぶ渡り部に加工硬化部を設けたことにより、この加工硬化部において、外力に対する強度が高くなり、かつ透磁率が高くなるというように２つの特性が同時に変化している。従って、渡り部の強度を確保して変形や破壊を防止し、かつ渡り部からのもれ磁束を低減してモータ性能を向上させるという両効果を同時に奏することができる。

【００４５】本発明の一態様では、ロータに用いられる磁極積層体を形成する積層板において、磁石用開口部の肩部とロータ外周の間の幅狭の部分（すなわち渡り部）に加工硬化部を設けたことにより、ロータ磁石に作用する遠心力に基づく曲げモーメントに対する渡り部の強度が増加し、かつ、磁石用開口部の外側の磁極から渡り部を通ってその他の積層板部分へもれるもれ磁束が低減する。

【００４６】また、本発明の一態様では、ステータに用いられる磁極積層体を形成する積層板において、凸極間を内周側で連結する幅狭の連結部に加工硬化部を設けたことにより、連結部の外力に対する強度が増加し、かつ、連結部へもれるもれ磁束が低減する。

【図面の簡単な説明】

【図１】　本発明の第１実施形態のモータのロータ積層板の形状を示す説明図である。

【図２】　積層板の圧縮変形処理による特性の変化を示す説明図である。

【図３】　本発明の第２実施形態のモータのステータ積層板の形状を示す説明図である。

【図４】　従来技術１のモータの構成を示す断面図である。

【図５】　図４のモータのロータ積層板の平面図である。

【図６】　従来技術２のモータの構成を示す断面図である。

【図７】　図６のモータのステータ内筒積層板の平面図である。

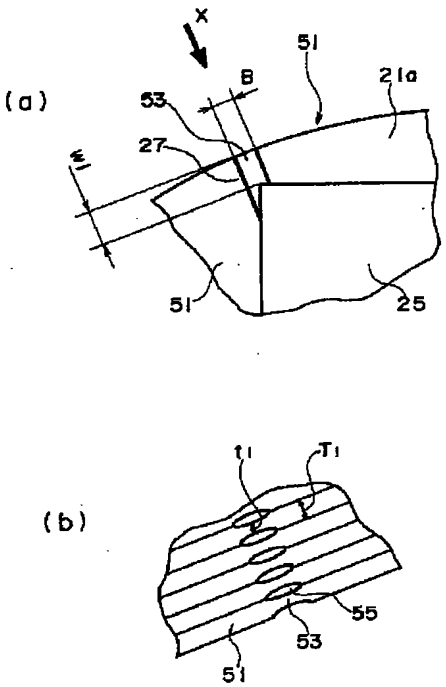
【図８】　図４のモータの円Ａの部分の詳細図である。

【図９】　図６のモータの円Ｂの部分の詳細図である。

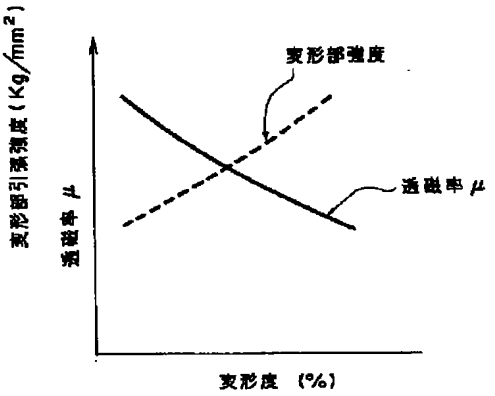
【符号の説明】

１，３１　ステータ、３　ロータ、５，３３　ステータ本体、９，４３，４３ａ　凸極、１１　ステータ巻線、１３　ロータ本体、１５，５１　ロータ積層板、１９　ロータ磁石、２１，２１ａ　磁極、２５　磁石用開口部、２７　渡り部、３５　ステータ外筒、３７　ステータ内筒、４１，６１　ステータ内筒積層板、４５，４５ａ　連結部、５３，６３　加工硬化部、５５，６５　空隙。

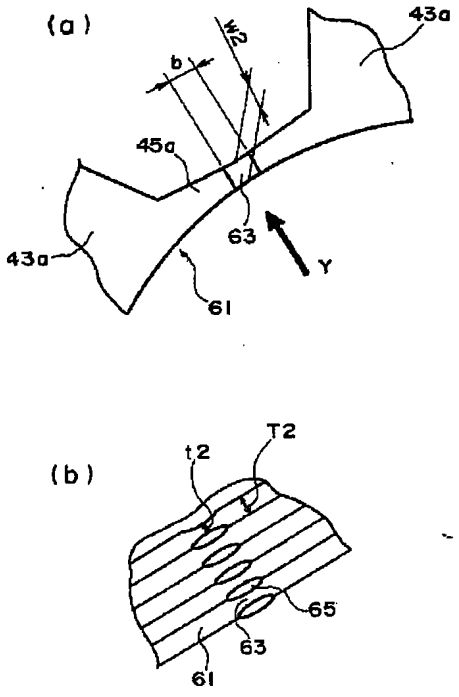
【図１】


(a)
X
51
B
21a
53
27
t1
51
25
(b)
t1
T1
55
53
51

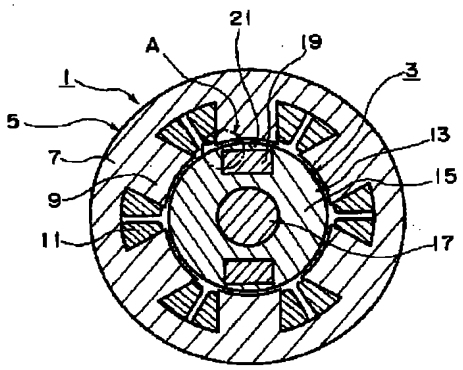
【図２】


変形部引張強度 (Kg/mm²)
変形部強度
透磁率 μ
透磁率 μ
変形度 (%)

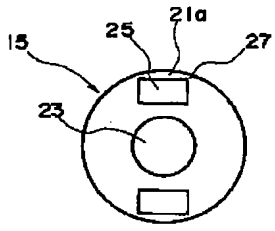
【図３】


(a)
43a
t2
b
45a
63
43a
Y
61
(b)
T2
t2
65
63
61

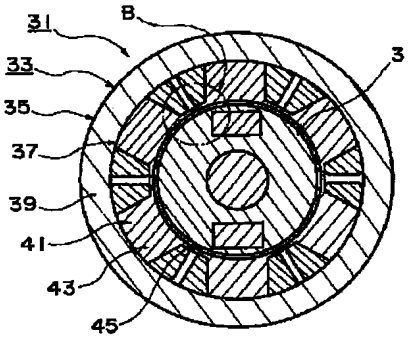
【図４】


21
A
19
1
3
5
13
7
15
9
11
17

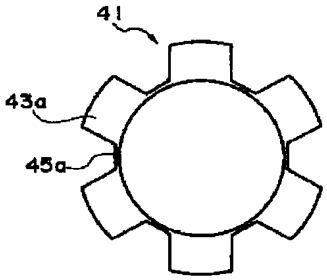
【図５】


21a
25
27
15
23

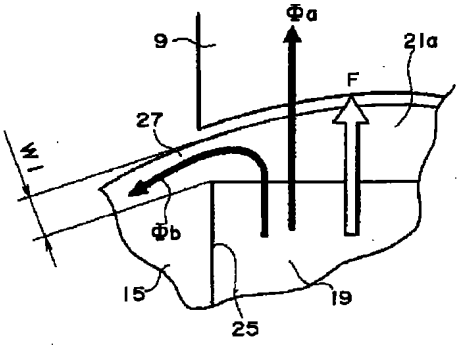
【図６】


31
B
3
33
35
37
39
41
43
45

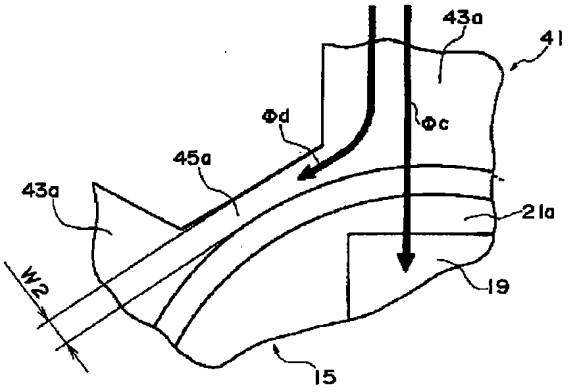
【図７】


41
43a
45a

【図８】


Φa
9
21a
F
27
W1
Φb
15
25
19

【図９】


43a
41
Φd
Φc
45a
43a
21a
W2
19
15